The Dutch DCS-1800 Auction

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THE DUTCH DCS-1800 AUCTION

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ABSTRACT

In February 1998 the Dutch government auctioned licences to operate mobile telecommunications networks according to the DCS-1800 technology. Two “national” licences and sixteen “regional” ones were auctioned by using a variant of the simultaneous, multiple round auction that was proposed by US-economists and that had been tested in the US. This paper describes how the decision to auction came about, it details the auction rules, and it analyzes the resulting outcomes.

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1. INTRODUCTION

The increasing demand for (use of) frequency spectrum has made governments aware of the fact that spectrum is scarce and that traditional methods of spectrum allocation (on the basis of the first come first served principle, by lottery, or by means of a beauty contest) are inadequate. Worldwide it has been argued that the market mechanism could be used to ensure more efficient allocation and use of spectrum. The first spectrum auctions, in Australia and New Zealand, however, made use of traditional first price or Vickrey formats, and proved to be a mixed success. Following the advise of economic theorists and game theorists, the US-government decided to adopt a new design to auction spectrum, the multi round simultaneous auction. Using this auction format, the US-government has raised several billions of dollars. These auctions have been well documented and they have been described as a success for all parties involved. The new format has also sparked a new wave of economic theorizing (Cramton (1995, 1997), Mc Afee and Mc Millan (1996), Mc Millan (1994, 1995), Milgrom (1996, 1998)).

In 1995, the Dutch government decided to make use of the auction mechanism to allocate spectrum rights for commercial use and, in February 1998, the first such auctions were held. In these, licences to use frequencies in the DCS-1800 band (usable for mobile telephony) were auctioned. It was decided to make use of a variant of the simultaneous multi round ascending auction that had proved so successful in the US. However, the auction rules differ in important details from those that were used on the other side of the Atlantic. In this paper, we describe the auction rules as they were used in the Netherlands and discuss the implications of the differences. We also present and analyze the actual results of the auction.

While the Netherlands is not the first European country to sell spectrum licences, it is the first European country to generate a substantial amount of money from them. (See Keuter and Nett (1997) for a description of early spectrum auctions in Germany.) Given that a good design is crucial for the auction to be a success and given the consensus that the US-auctions were a success exactly because of the fruitful interaction between academic economists and government officials, it is interesting to investigate the interaction between academics and practitioners in the Netherlands. Why did the Dutch government agency not implement exactly the same rules as in

the US? What was the rationale for the changes? What role did academic economists play in the process? This paper answers these questions.

The process which led to the auction is interesting in particular because of the interaction that took place between the Dutch government and the European Commission. The latter played the leading role in the liberalization of European telecommunications markets by pushing strongly in favor of eliminating any advantages of incumbent telecommunications operators. In various directives, the Commission has argued for asymmetric regulation so as to enable a "level playing field" between incumbents and newcomers. (See especially the directive 96/2/EG.) The exact meaning of the phrase, however, is not completely clear and asymmetric treatment may violate basic principles of equal treatment. We will encounter a concrete example below. Secondly, the Commission has stated its reservations against using auctions to allocate licences, this because of the fear that the auctions might eventually result in higher prices for users. While one may doubt the economic underpinnings of this argument, it certainly played an important role in the political discussions and might have blocked the use of the auction mechanism completely. Thirdly, the Commission is suspicious of national governments creating artificial scarcity and it thus basically forces governments to make available all spectrum that is not used. As we will see, because of all these aspects, the European Commission had a crucial influence on the amount of spectrum supplied by the government, on the auction rules and, hence, on the final allocation.

The remainder of the paper is organized as follows. Section 2 describes the lengthy process leading to the Dutch DCS-1800 auction. Section 3 describes supply and demand in the Dutch DCS-1800 market and details the auction rules, stressing the important differences with the PCS-auctions as they were played in the US. Section 4 analyzes the auction outcome and some peculiarities that were observed during the play. Section 5 concludes.

2. THE PROCESS LEADING TO THE AUCTION

In this section, we briefly describe the lengthy process that eventually led to the Dutch DCS-1800 auction. We focus on the role that game theorists and economists played in this process and on the interaction between political decision making bodies at the national and European level, specifically on the intervention by the European Commission that led to changes in the auction rules.

The Netherlands was a relative latecomer in the field of digital mobile telephony. The incumbent fixed telephony operator (KPN) was given (for free) a licence in 1994, at about the same time as it was privatized. In 1995, a "beauty contest" was organized to award a second GSM-licence. The licence was won by Libertel, a join venture in which Vodaphone and the Dutch ING-bank were the main shareholders. While also this licence was awarded for free, the tender document contained statements that the winner might be charged ex post for its licence.

The selection of the winner of the beauty contest involved a lot of controversy: the selection process had taken a long time, it was not clear that the "best" party had been selected, and several parties threatened with law suits against the government. This negative experience led the government to investigate the possibility of using auctions to allocate spectrum. Informed by the positive PCS-auction experiences in the US, parliament agreed and started the process of law changing to enable such auctions. Quite naturally, Dutch economists were keen to disseminate the positive news from the US. Economists from the University of Amsterdam were the first to do so (Bykowski et al, 1995).

At that time, however, relatively little knowledge about auctions was available in the country. A good illustration is provided by a government document from 1993 in which we read the following description of the Vickrey auction: "the one who has made the second highest bid receives the lot; this prevents excessive bids being made" (HDTP, 1993, p. 39). The game that is described here is interesting, and it prevents excessive bids, but it is not the Vickrey auction. We find similar misunderstandings in later parliamentary texts. During 1996, I was asked by people from the Ministry of Finance to advise on auctions. The questions asked ranged from very general ones (pros and cons of auctions?, do auctions lead to higher consumer prices? how to prevent collusion?) to specific ones about actual auction design. I got similar questions from the

Ministry of Economic Affairs and wrote a report (Van Damme, 1997a) that made the results from the literature available to a wider audience. A summary (Van Damme, 1997b)was published in the widely read weakly magazine ESB under the title “10 misunderstandings about auctions”. Indeed, misunderstandings were widespread, even among the consultancy firm that was hired by the government to advise on the actual auction design. (See my letter contained in the consultation document DDV 1996.)

Meanwhile, the government had prepared a law to allow auctioning the DCS-1800 spectrum. The law stipulated that one new licence be auctioned, that incumbents be excluded from this auction and that incumbents would pay a fee, related to the auction price, for the licences they had gotten for free in the past. All these aspects, as well as the auction itself proved controversial. We briefly touch upon the reasons why, for details we refer to the parliamentary texts. (See second and first chambers of parliament, numbers 24095 and 25171.)

While parties generally accepted that auctions have attractive features, some parties nevertheless argued against auctions because they feared that they would lead to higher consumer prices and would slow down investment. These views, while incorrect according to standard economic theory (McMillan 1995), echo those of the European Commission. In particular, see the Commission’s Green Paper concerning a common approach to mobile and personal communications in the EC, point 40, p. 23.

In order to avoid that governments exploit their monopoly power by creating articificial scarcity, EC Directive 94/96/EG concerning mobile communication states that the number of licences can be limited only in case of essential capacity constraints. Hence, the Dutch government could limit supply to one licence only in case no more spectrum was available. As we will see below, the EC, however, forced the Dutch government to sell considerably more spectrum that it had intended at first.

The government argued that exclusion of the incumbents was compatible with EC directive 96/2/EG concerning mobile and personal communications (Pb EG L20, 26-1-96). After all, this directive states (in consideration 8) that exclusion is allowed if otherwise there could not be

effective competition, in particular because a dominant position would be strengthened.. Now, at the time of the auction, KPN had a market share of about 2/3 and Libertel about 1/3, so that Libertel certainly did not have a dominant position. It is thus not surprising that Libertel was to challenge its exclusion. (See below.)

Finally, the ex post levy on incumbents was justified by the desire to create a "level playing field", newcomers would be disadvantaged if they had to pay for licences where incumbents had gotten similar licences for free. The law proposed an explicit formula linking the levy to the auction price, based on the principle that one MHz of GSM-spectrum has the same value as one MHz of DCS-1800 spectrum. Lawyers argued that the ex post levy was unjustified (that it was in conflict with the basic principle of trust) as it could not have been foreseen, while the economists argued that such a fixed payment does not contribute to create a level playing field (sunk cost are irrelevant for market behavior).For example, Sweder van Wijnbergen made this argument on behalf of Libertel.

Despite all this criticism, the responsible minister, however, saw little reason to change the law. There is only one change that she accepts: instead of one licence, two licences will be auctioned. The reason for this change are international agreements which imply that additional spectrum (in the extended GSM-band) can be allocated to mobile operators, hence, more capacity is available. With one further minor amendment, the second chamber unanimously approved the new law on June 17, 1997.

Less than 2 weeks later, however, EU-commissioner Van Miert writes a letter to the minister in which he requests not to apply the new law to the upcoming allocation of DCS-1800 licences. He proposes to use auctions only for new markets. Van Miert points out that if the new law is used to assign DCS-1800 spectrum, one might receive complaints from new or incumbent operators that might be bad for the development of the market. Indeed already on July 8, 1997, Libertel issues a complaint with the Commission. Libertel contests the scarcity levy, its exclusion from the right to bid on the DCS-1800 frequencies, and it objects to the fact that only a limited amount of spectrum is brought to the market.

On September 1, Van Miert writes the Minister that, in his first opinion, the complaint of Libertel is hard to refute: in order to be foreseeable, the levy should have been specified in a more detailed way when Libertel's licence was awarded,, exclusion of Libertel cannot be justified on competition grounds, and spectrum which is available, or which will become available soon, has to be offered in the same auction. Van Miert thus urges the Minister to consider an alternative procedure. On October 7, the Minister reports to the parliament about this and she decides to change the law. In fact, the government gives in on all three points: there will be no scarcity levy (not for Libertel, neither for KPN), more spectrum will be auctioned, and incumbents will not be allowed to bid on parts of this spectrum.

For several reasons the exchange of views on the "level playing field" is interesting. At first, the Minister saw the need to levy a scarcity fee in order to comply with EU-directives. Indeed, earlier the European Commission had forced the Belgian, Italian and Spanish governments to charge their former telecom monopolists for the GSM-licences they had gotten for free after a second GSM-licence had been sold on the market. For example, Proximus (the mobile division of Belgacom) initially paid only Bfr. 3.5 million for its licence, while Mobistar (the second entrant in Belgium) had to pay Bfr. 9 billion. Van Miert insisted that Belgacom be forced to pay Bfr. 5.5 in addition. According to the Belgian newspaper De Standaard (20 Sept. '95) Van Miert said "The Commission has always stated clearly that it should be possible for newcomers to enter the market under the same conditions, hence, Belgacom knew what it could expect." Now, however, it turns out that the Commission objects to such a fee, hence, newcomers cannot enter under the same conditions. This raises the question of why the Dutch case is different? Again not surprisingly, newcomers have since complained to the Commission that the asymmetric payments violate the EU-principles and they have argued that they not be forced to pay the auction price.

All this, however, implies that the ministry gets under extreme time pressure for, after all, the EC-directive 96/2/EG stipulates that DCS-1800 licences have to be issued before January 1, 1998. The minister gets the parliament to cooperate in a quick procedure to change the law. The discussion in parliament is mainly political and does not focus on content.As far as content is concerned, discussion focuses mainly on old issues (such as do auctions lead to a higher price) and there is very little discussion about the important issue about how the supply of spectrum has

to be packaged. Even though some parties argue that it would be desirable to discuss the actual auction design, one realizes that time is too short for that and MP's are satisfied after the Minister has repeated her earlier claim that an extensive process of consultation has shown that a multi round simultaneous auction is to be preferred. After the superficial discussion, both chambers of parliament accept the new (revised) law. The second chamber accepts it (unanimously) on November 18, 1997 and the first chamber, (also unanimously) on November 25, 1997. In the next subsection, we describe the final version of the law.

One may doubt, however, whether the consultation process was as extensive as the Minister claimed it to be. As far as I know, the only serious investigation about the proper design was done in the Summer of 1996 by researchers from the CREED laboratory in Amsterdam. The researcher's report (Olsen et al (1996)) is datd September 30, 1996 and is based on the assumption that only one licence will be auctioned, see p. 15, hence, it does not deal with the intracies of how to auction multiple goods with complementarities. Indeed, I was told later that, in the end, a high official at the Ministry wrote down the rules of the game on one Friday afternoon.

3. THE AUCTION RULES

In this section we describe the lots that were auctioned, the auction rules and the bidders. The ministry published the detailed regulations concerning the auction on November 26, 1997, immediately after the new telecommunications law had come into effect on November 25. Interested parties had to register before mid January. The auction itself started on February 12, 1998, and ended on February 26 after 137 rounds. There was a lot of secrecy involved, only after the first round of the auction did a player find out whether all reportedly interested parties were indeed eligible to bid, and on which lots.

3.1 The lots

In total 72 MHz of DCS-1800 spectrum and 10 MHz of E-GSM spectrum was auctioned. There were 2 big lots (A and B), each consisting of 5 MHz of E-GSM-spectrum and 15 MHz of DCS-1800 spectrum. (15 MHz is the equivalent of 75 channels (frequencies).) In addition, there were 16 small lots that had in total 42 MHz of spectrum. Not all frequencies are identical however. The same frequencies have been reserved for DCS-1800 in Belgium, Germany and the Netherlands, but the operators using these frequencies differ in different countries and this might give rise to problems (of interference) in a border area.. To prevent these difficulties, agreements have been made concerning which country (-operator) has priority in case of simultaneous use. Hence, there are 4 different types of frequencies: those for which one has priority both against Belgium and Germany (H), those for which one has priority only against Belgium (B), those for which one has priority only against Germany (G) and those that do not have priority (N). Table 1 provides details.

Lot	F	H	B	G	N	MHz
A	75	25	12	12	26	15
B	75	25	12	12	26	15
1	13	6	0	0	7	2.6
2	12	12	0	0	0	2.4
3	13	0	0	0	13	2.6
4	12	0	12	0	0	2.4
5	13	7	0	6	0	2.6
6	12	0	0	6	6	2.4
7	13	6	0	0	7	2.6
8	12	12	0	0	0	2.4
9	13	0	0	0	13	2.6
10	12	0	12	0	0	2.4
11	13	7	0	6	0	2.6
12	12	0	0	6	6	2.4
13	13	6	0	0	7	2.6
14	12	12	0	0	0	2.4
15	13	0	0	0	13	2.6
16	22	6	12	4	0	4.4

Table 1: Details about the lots (F= # frequencies, H= # frequencies with priority w.r.t. Belgium and Germany, B = # frequencies with priority w.r.t. Belgium, G = # frequencies with priority w.r.t. Germany, N = # frequencies without priority)

3.2 Players in the auction

There were 7 players in the auction. The two incumbent GSM-operators, KPN and Libertel, were eligible to bid on all small lots. In addition, there were 5 new entrants: Telfort (a joint venture of BT and the Dutch railroads), that also has a licence to operate a fixed telephony

network), Federa (a joint venture of France Telecom, Deutsche Telekom and 2 Dutch banks (ABN/AMRO and RABO), Orange/Veba (a consortium of the British mobile operator Orange and the German mobile operator Veba), Airtouch (a US baby bell) and TeleDanmark. France Telecom was already active on the Dutch market, in 1997 it had bought the largest Dutch cable network (Casema) when KPN had been forced to divest this. TeleDanmark was already active in Belgium, it is a shareholder in Belgacom (15 percent), together with (among others) Ameritech (20 percent), the Chicago based baby bell.

3.3 The auction rules

The auction rules distinguish between incumbents and entrants. Incumbents (KPN and Libertel) are not allowed to bid on the lots A and B, but they are allowed to bid on all of the lots from 1, ..., 16. Each newcomer is allowed to bid on any of the lots for which he has paid a deposit.(All players had paid deposits for all of the lots for which they were eligible.)

The auction involves multiple rounds of simultaneous bidding. The minimum bid in round 1 is 0 for each lot.

At the beginning of round $t+1$, each player receives information about what happened in round t. Specifically, for each lot it is revealed how many bids there were in the previous round, what was the highest bid (rounded to the nearest multiple of 100,000 (resp. 10,000) for the large (resp. small) lots and how many bids were highest. For those lots for which there was no activity in the previous round, the information from the round before is carried forward, i.e. each bidder is reminded of the highest bid that has been made up to now for each lot. In addition, each bidder is *privately* informed about on which lots he is standing highest.

At the beginning of each round, each player also receives information that is relevant for that round. Specifically, each player gets to hear the minimum bid that has to be made on each lot and the number of parties that is eligible to bid on that lot. The minimum bid is determined by the auctioneer. It is equal to the present (non rounded) highest bid for the lot plus an increment which lies in the range of 0 to 10 percent of that bid. A player that is eligible to bid,

can bid on as many lots that he wants, with the exception that a bidder who is standing high on A (resp. B) is not allowed to bid on B (resp. A). Who is eligible to bid is determined according to the following rules:

i) If player *i* bids in round *t*, then *i* is eligible to bid in round *t+1*;

ii) If, when entering round *t*, player *i* is having the highest bid on lot k, and player *i* is overbid on k during round *t*, then *i* is eligible to bid in round *t+1*;

The auction continues until there is a round in which no bids are made. The lots are then allocated to the bidders that are standing high at that point in time and these pay their bids. The auctioneer has the discretionary power to announce the last round if, in his opinion, the auction is taking too long. In such an announced last round, the parties that are eligible to bid are, in addition to those determined according to i) and ii) above, all those parties that are standing high when entering this announced last round. This latter rule did not have to be involved in the actual auction.

Besides the asymmetric treatment of incumbents and entrants, we may note the following differences with the auction design that was used in the US PCS-auctions:

a) In the Dutch case, there is no equivalent to the US-activity rule: a party that is interested in lot A or B is not forced to be active on a combination of lots of a similar size, he can decide to remain active only on one of the smaller lots. The absence of such an activity rule makes “hiding in the grass” a more attractive strategy, which might prolong the auction considerably.

b) In the Dutch case, a player is not allowed to withdraw his bid. As a consequence, the possibility of inefficient lock-in is more likely and bidding on the smaller lots in order to aggregate a nationwide network is less attractive.

c) In the Dutch auction, there is no common knowledge about who is standing high on which lots in a round. Each player is only privately informed about where he is standing high. However, it is not forbidden for a player to inform the others where he is standing high.

3.4 Auction outcome

The following table 2 specifies which bidders acquired which lots, and what price was paid. A and B licences were awarded to Federa (Dfl. 600 million) and Telfort (Dfl.545 million), while KPN acquired 7 small lots; Libertel and Orange/Veba, 2 lots apiece; TeleDanmark 4; and Telfort 1. The State came out ahead by 1,835 million guilders.

Lot	**Winning bidder**	**Price (Dfl x million)**
A	Federa	600
B	Telfort	545
1	Libertel	40.4
2	KPN	40.2
3	Orange	38.0
4	Telfort	40.5
5	KPN	43.0
6	TeleDanmark	41.1
7	KPN	40.4
8	KPN	39.1
9	Orange	46.5
10	TeleDanmark	41.25
11	KPN	42.98
12	TeleDanmark	39.9
13	KPN	39.9
14	KPN	40.5
15	Libertel	45.5
16	TeleDanmark	71.5

4. ANALYSIS AND EVALUATION

As Mr. Zalm, the Finance Minister, remarked afterwards, the outcome was indeed ‘a nice, tidy sum’. The government, however, had consistently emphasized that the proceeds were only a secondary goal, and that the main purpose behind introducing the auction mechanism had been to create a quick, transparent process that would lead to an efficient outcome. In this section we address whether this goal was achieved. We first analyze the auction outcome; in a second subsection, we focus on some peculiarities observed during the course of the game.

4.1 The auction outcome

Was this goal of efficiency really achieved? A more detailed look at the outcome casts some doubts. First of all note that ‘The Law of One Price’ does not hold: identical goods were not being sold for the same price - something that would indeed be the case in a perfect market. Although the technical specifications for lots 3, 9 and 15 were identical, for example, they were sold for Dfl. 38, 46.5 and 45.5 million respectively - yielding a spread in prices of about 20 percent around the mean. (For the other groups of two and three identical lots, the difference was not as great.)

Another interesting feature was the price paid for each frequency. This varied from Dfl 2.92 million (for lot 3) to 3.58 million (for lot 9). The standard deviation was 0.17 with a mean of 3.29 - in other words, a spread of 5 percent. Recall, however, that different frequencies are imbued with different rights, so that the difference in rights should be reflected in price. By using a simple regression, the implicit price for each of these rights can be revealed. If we limit the regression to lots 1 to 16, we find that:

P =	3.22 H +	3.40 G +	3.34 B +	3.26 N	(R^2=0.93)
	(32.8)	(16.6)	(28.6)	(35.8)	

(with t-values indicated between parentheses).

Surprisingly, the H-frequencies (i.e. those that offer the most rights) have the lowest price. The differences are not significant, however, and the hypothesis that all coefficients are equal cannot be rejected (p value = 0.74). Still, we believe that the behavior of the large incumbent, KPN, demonstrates that H-frequencies do have higher value. For example, while KPN bought approximately 1/3 of all frequencies in the small lots, of all 74 H-frequencies available in these smaller lots, KPN bought 62! Apparently, KPN believed these frequencies to constitute value for money. Even more importantly, the regression equation illuminates a fundamental price difference between lots A and B and the 16 small ones: on the basis of the prices paid for the small lots, the predicted value of lots A and B is 246.4 million (with a 95% confidence interval of (236, 256)). This predicted value differs significantly from the realized prices of 545 million and 600 million, respectively. The difference in price can be seen in yet another way: the combination of lots 3, 4, 8, 11, 12 and 13 yielded exactly the same capacity (in regard to the DCS band) as A and B but cost only 240.3 million.

How can this price difference be explained? One possible explanation may lie in the fact that the E-GSM part of the A and B licences has not yet been taken into consideration. Before doing so, however, it is worth asking whether the E-GSM part represents any real value: a bidder wanting to utilize both DCS-1800 and E-GSM would have to use special mobile telephones which are not yet on the market and may not even be available within the next two years. Within that time, the bidders would already have rolled out their DCS-1800 network and would no longer need E-GSM. E-GSM, therefore, is of little value. The lower limit is zero, while an upper limit is obtained by making 1 E-GSM frequency equal to 1 DCS-1800 frequency. Since A and B each have 100 frequencies, this means that the maximum value of A and B can be estimated at 329 million which is still less than 55% of what was ultimately paid. This explanation is therefore insufficient. Neither, using a similar line of reasoning, can the difference be explained by the special ‘roaming’ rights attached to A and B. (This right, of national roaming with one of the GSM-operators, applies only temporarily, and is probably compensated by the obligation to roll out a full nationwide network within a certain time span).

A better explanation for the observed price difference lies in the auction rules, in particular the

lack of transparency during the auction process and the fact that bids cannot be withdrawn. Given the inability to withdraw a bid, the cost of the lots that a bidder at present is standing high on constitute a "sunk cost", so that the bidding on the small lots becomes a war of attrition. In such a situation, the highest bid wins, but each bidder, also a loser, must pay the price of his bid**.** The simplest example of this is the 'dollar auction', introduced in Shubik (1971), in which one dollar is auctioned: after bidder A has bid $ 0.60 and bidder B has bid $ 0.70, bidder A must choose between accepting his loss or taking the risk of bidding even higher. The temptation is to bid higher and the lot is sold for substantially more than its true value. Experiments show that such wars of attrition commonly induce inflated prices, and specific experiments with the Federa team carried out before the auction showed this to be the case here. Players expecting such a price war may rationally decide not to bid on the smaller lots.

The endurance required of bidders is further intensified because bidders are unable to see *which* of the other bidders has made the highest bid. If a bidder decides to try to form a network that will cover the country by means of accumulating small lots, he will have to compete with all possible opponents; he cannot localize the competition in order to concentrate efforts

The inability to withdraw bids, also implies that a bidder might get stuck with a few single lots that will turn out to be worthless (this is actually the situation in which Orange/Veba found itself). Finally, given budget constraints and the impossibility to withdraw bids, combined bidding on the large and small lots is a risky business. Every sum committed to the small lots is unavailable for bidding on the large lots, and it is quite possible that Orange/Veba lost out to Telfort and Federa precisely because it had spread itself too thin**.** Indeed, after the auction it was revealed that parties were willing to go to the limit of Dfl 600 mln to obtain a licence. With this budget, Orange/Veba could not overbid Telfort on lot B as the minimum required bid was 570 and the firm had committed 84.5 on lots 3 and 9.

All these reasons indicate that bidding for small lots was not deemed attractive. In practice, bidding activity during the auction concentrated on the large lots, and no bidding activity took

place on lots 1 to 16 for a long time before the auction closed. The low level of bidding for lots 1 to 16 provided KPN and Libertel with a clear advantage, where the original idea was that these bidders should be discriminated against..

In all probability, the specific auction design and the resulting avoidance of small lots by entrants has also caused the auction outcome to be inefficient. First of all, for Telfort lot 4 is redundant as lot B alone offers enough capacity, hence, lot 4 does not offer much value for this player. Secondly, the two lots that Orange/Veba acquired are insufficient to roll out a network, hence, an assignment of two lots to this party is not efficient. Before it be concluded that this party has temporarily squandered DFL 85 million, it should be realized that the rules allowed Orange/Veba to resell the licenses, subject to permission by the State. These rules state that reselling to other active players is not possible, but that permission might be granted if the sale is to new parties. After the auction TeleDanmark has set up a new company, currently active under the name “Ben”, that has bought the licenses of both TeleDanmark and Orange/Veba. Other parties have issued a complaint that it was not justified for the Minister to give permission. In any case, the fact that resale took place is evidence of inefficiency of the auction outcome. We note that the Orange/Veba behavior appears slightly difficult to explain: given that they were willing to bid on small lots, why did they fail to continue their bidding on 1 to 16 when they realized that A and B were unobtainable? If they could have accumulated additional lots for the stated closing prices, they would have been able to put together a national network (for Dfl. 288 million if they had purchased lots 1, 2, 6, 7 and 10). Perhaps Orange/Veba also believed this strategy to be too risky: after all, the other bidders would not just stand around doing nothing, but would probably retract their lots and drive up prices.

As a third indication of inefficiency, we note that it is not clear that TeleDanmark was, after Telfort and Federa, the player with the third highest value. There were at least three parties that were willing to pay more than Dfl 550 million for a national network, and one of these (Orange/Veba) was eliminated. If TeleDanmark valued the license at less than Dfl. 550, the third licence was thus awarded inefficiently. In any case, a different auction design, or a different packaging of the licenses, might have led to three national networks being sold for at least Dfl.550 million each, hence the State could probably have generated more revenue.

What must be concluded, then, is that the auction outcome was not efficient and that the State could have obtained higher revenues. An alternative auction design, like, say, the model used in the USA for mobile telecommunications or a combinatorial auction , could have eliminated the problems which emerged. The American system of auctioning has three advantages over the Dutch system. Firstly, there is an activity rule that forces bidders to remain active and which accelerates the course of the auction. Secondly, bidders can withdraw their bid when they see that they are no longer able to create an efficient accumulation of lots, and this leads to more aggressive bidding. Finally, and most importantly, bidders in the American auction system have common knowledge about the state of the auction at any time, i.e. everyone knows who is currently standing the highest on any given lot. The availability of such information makes the situation transparent to participants and leads to both higher bids and more efficient allocation.

Obviously, the interesting question is why an alternative design, such as the American auction system, was not used in the Netherlands. We have already indicated the answer in the previous section: not enough time was devoted to thinking through the intricacies involved, probably because it was not realized how crucial the details in the game rules can be. Expert opinion was sought when it was not really needed, when it became more crucial, after the idea of a single new national licence was abandoned, it was not sought again.

The Minister tried to justify the choice by brushing aside the criticism and claiming that the provision of information would encourage the formation of bidder cartels, with a detrimental effect on the outcome. For example, see the remarks of Minister Jorritsma-Lebbink during the discussion on the law in the first chamber of parliament, November 25, 1997. (Verslag EK, p.8-355). We find this rather unconvincing, given that the parties were cooped up together in the same hotel for two weeks with plenty of opportunity to conspire outside the 9-5 hours that the auction was running.

4.2 The auction process

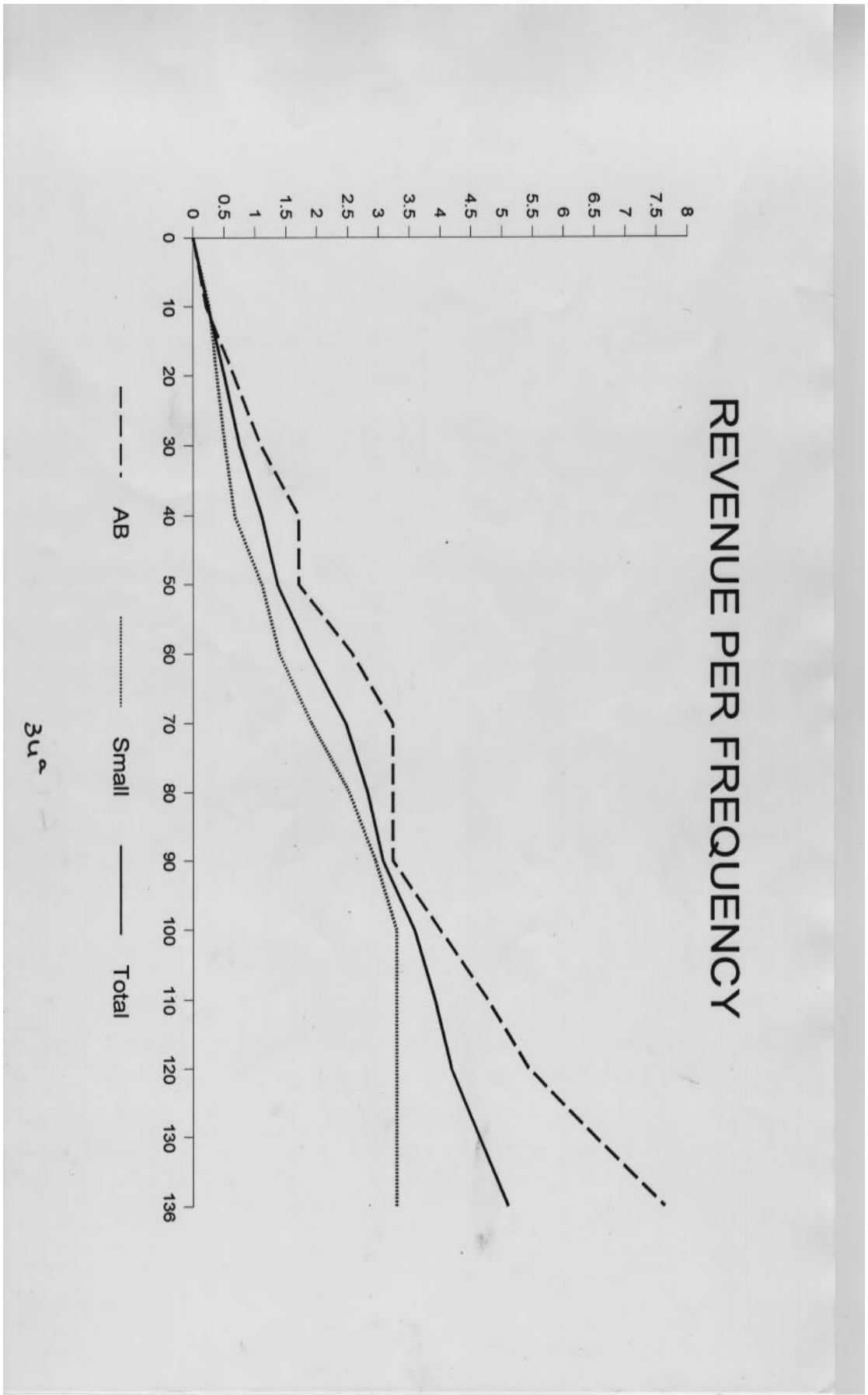
I was asked by the Federa team to provide them with game theoretic advise on how to play in the auction. Together with other researchers from Tilburg (Sander Onderstal and Henk op den Brouw, in particular) we analyzed simple models, did simulations and performed experiments. Later on, the group of prof. Selten (Bonn) was called in for the experimental sessions as well. These mock auctions showed that bidding on the smaller lots was quite a risky business: in several experimental sessions, the smaller lots were sold at a much higher price per frequency than the large lots. The reason is the so called “exposure problem” that was already referred to above. See also Bykowski et al (1998). Similarly, the experiments and simulations showed the riskiness of bidding on both small and large lots. Having seen the risks involved, the Federa team decided that it would bid only on the large lots. Apparently, Telfort had reached a similar conclusion as it also bid exclusively on the large lots.

The next table gives the bidding activity (average number of bids per lot) during consecutive stages of the auction. As one can see, at the start there was activity on both small and large lots. When large lots became relatively more extensive, bidding intensity on them decreased and during the periods 41-50 there was bidding only on small lots. This drove up the prices of the smaller lots which induced bidding again on large lots. The process repeated itself with no bidding on large lots during periods 71-90. After round 98, there was no more activity on the small lots.

Round	Large	Small
1-10	1.2	0.3
11-20	1.4	0.15
21-30	1.0	0.19
31-40	0.75	0.20
41-50	0.	0.47
51-60	0.65	0.21
61-70	0.25	0.34
71-80	0	0.32
81-90	0	0.22
91-100	0.35	0.12
101-136	0.5	0

Table 3: Bid activity

As bidders typically made bids at the minimum required level set by the auctioneer, the auction revenue increased at a more or less constant rate. The following figure displays the evolution of revenue per frequency during the auction. We see that, throughout the auction, smaller lots were cheaper but that the difference was small around round 90. At that point, bidding intensified again on the large lots and, as already seen above, the final per unit price was much larger for the larger lots than for the smaller ones.


REVENUE PER FREQUENCY
8
7.5
7
6.5
6
5.5
5
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
0
10
20
30
40
50
60
70
80
90
100
110
120
130
136
AB
Small
Total
34

From round 98 onwards, there was bidding only on large lots and only 3 parties (Federa, Orange/Veba and Telfort) were eligible to bid. At that time, Airtouch and had already left the auction. It had made a jump bid (bidding more than the required minimum) of 225 on B in round 65, when this bid was overbid in round 95, it announced its withdrawal. The other parties were not active and were not activated by the bidding parties. During the auction, rumor had it that Libertel regretted this situation. According to newspaper reports, that party had made a mistake during round 98 making it ineligible to bid in future rounds.(Interestingly, round 98 took place on "Carnival Monday", a day of celebrations and drinking in the south of the Netherlands, where Libertel is based.) Bidding from round 99 till almost the very end of the auction was very boring with the current "outsider" just bidding the lowest bid required (the minimum set by the auctioneer) to replace an "insider" This pattern was broken only in round 132 when Telfort first made a slight jump bid. The next table describes the end of the auction (M_i denotes the minimum required bid on lot i, B_i the bid, and B denotes the bidder: O = Orange, T = Telfort, F = Federa).

Round	M_a	M_b	B_a	B_b	B
132	500	510	505		T
133	520	510		510	F
134	520	530	540		O
135	560	530		545	T
136	560	570	600		F
137	630	570	-----	-----	-----

Table 4: Endgame

Note the jump bid of Federa in round 136 in particular. Apparently, Federa had a budget of Dfl 600 mln. Given this, it did not make sense to bid less than the budget: it would have increased the probability of being overbid while the budget would not have been sufficient to raise the bid. In that case, the auction would have been lost with the principals of the bidding team members having as a possible argument that this was because the team had not gone to the limit. From the agents' perspective, going to the limit was clearly the best thing to do.

As information was scarce during the auction, each player having private information, one could expect signaling to occur during the auction. In the initial phase of the auction, players signaled by using special combinations of digits and by bidding on consecutive lots. For example, in round 46, the bids on lots 1-4 ended on .21, while those on 9-14 ended on .25. The clearest signals were sent by TeleDanmark. In round 37 this bidder sent around a memo to the other bidders stating “please note that TeleDanmark was highest on the lots 1 through 6 with prices of 9.21, 9.21, 9.21, 9.21, 9.21, and 7.61”. In rounds 38-41 this bidder ws not overbid on these lots and it sent a memo saying “please note that TeleDanmark did not bid in this round”. In following rounds, occasionally lots would be taken away from TeleDanmark with the bidder taking them back and it notifying others with memo’s of the above type. Clearly, TeleDanmark was trying to scare others away from six of the small lots by signaling its intentions. It, however, was not successful with this strategy and, by round 66, it stopped the signaling. From a theoretical point of view, it is interesting to know whether such signaling is advantageous, should the other players have reacted to it?

During the process, the Federa team was trying to reconstruct who was standing high on which of the small lots. Not bidding on the small lots itself, many combinations were possible and, in the end, the attempt to construct the state of the auction was not successful: there were too many degrees of freedom left after the signaling had stopped. Also in this respect, an incumbent like KPN, that was bidding extensively on small lots, had a considerable advantage.

5. CONCLUSION

The case described above is interesting for a couple of reasons:

i) The gaming that took place before the auction. Well aware of the fact that EU-directives force the minister to allocate all available spectrum, the incumbent, KPN, released the spectrum that was under its control at strategic points in time and thereby, more or less, made the government its hostage. The policy was successful in delaying the awarding of new licenses and helped in having an auction design that favored the incumbent .

ii) The interaction between the Dutch government and the European Commission. It remains interesting why the Commission ruled differently in this case than in the previous GSM cases in Belgium, Italy and Spain. Also interesting is the fact that KPN was successful as a free rider on Libertel. The Commission argued that Libertel could not be excluded and that a levy could not be imposed on Libertel; in the end also KPN was not excluded and neither did it have to pay for the GSM license that it had gotten for free.

iii) The auction game itself. In essential aspects, the rules are different from those that were used in the US and a comparison is instructive. We discussed some of this above, but clearly much more remains to be said, in particular theoretical and experimental analyses are invited: how does the packaging of the lots influence the outcome?,what are the consequences of allowing bid withdrawal?, is the exposure problem more serious when the state of the auction is not common knowledge?, is it desirable to signal? Some of this work has already begun, see, for example, Onderstal (1999) in which a simple theoretical model is given illustrating that a design a sin the Dutch case might indeed result in lower seller revenue than what could be obtained.

iv) The different role that economists in the Netherlands played in the process as compared to the role played by American academics.

My overall conclusion is that the auction format that was used in the Netherlands was not "optimal". Not only does it not generate maximal revenue for the government, neither does it guarantee an efficient allocation. In addition, it favored the incumbents. It would have been better to give more information to parties during the auction or to simply use the same auction format as was used in the US PCS-auctions. The main argument that was given before the auction for why the US-auction format was not used was that collusion should be prevented and that collusion would be to easy in that design. I don't find this argument to be convincing. Contacts between parties were not forbidden and, in response to the question by one of the parties of whether it could reveal information outside of the auction, it was answered that this was not forbidden. The bidding teams were cooped in the same hotel for 3 weeks so that there were plenty of opportunities for colluding outside of the game for those that desired to do so.

After I had published my critique on the auction in Dutch (Van Damme, 1998), questions were asked in parliament and the Secretary of State in charge addressed the above criticisms in a letter to parliament dated January 11, 1999. She argues that revenue maximization was not a goal and that any critique that revenue could have been higher is beside the point. More importantly, she disagrees with the conclusion that the auction outcome was inefficient . In particular, she argues that there is no evidence that the law of one price does not hold since also the E-GSM frequencies have value. As we have seen above, even taking their maximum possible value into account, a substantial price gap remains between the large and the small lots Furthermore, we have given other indications of inefficiency (resale and Orange willing to pay more than what TeleDanmark paid) that the Secretary does not try to refute. The Secretary also remains unconvinced that a different design could have done better: an activity rule would limit the flexibility of bidders too much, bid withdrawals would make current bids uninformative and providing more information could have led to strategic bidding and to collusion. She concludes:

> "The chosen auction model, simultaneous multi-round with many opportunities to switch between lots, guaranteed fine competition and proved adequate. The auction was quick and successful. The goal of the auction, to allocate scarce radio frequencies for mobile telephony in a transparent way has been reached".

I think the final word has not yet been said about this auction.

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